6/6/03-3264

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June 6, 2003

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Building N-26)
Norfolk, Virginia 23511-2699

Attn: Mr. Kirk Stevens, P.E.
Navy Technical Representative
Code EV23

Re: Contract N62470-95-D-6007
Navy CLEAN II, District III
Contract Task Order (CTO) 0219
Mean ERM Quotients for Inorganic Compounds in Sediment of Brinson Creek – FINAL
Marine Corp Base, Camp Lejeune, North Carolina

Dear Mr. Stevens:

The following information is being provided at the request of Ms. Gena Townsend, the United States Environmental Protection Agency (USEPA) representative on the Camp Lejeune Partnering Team, as a follow-up to information provided in a November 21, 2002 letter report regarding inorganics in sediment collected from Brinson Creek. The letter report provided a comparison of inorganics data in sediments to National Oceanic and Atmospheric Association (NOAA) Effects Range Low (ERL) and Effects Range Medium (ERM) concentrations provided by Buchman (1999). Ms. Townsend has requested that in addition to this information, mean ERM quotients (ERM-Qs) be calculated for each sample location and that these quotients be used to categorize the relative potential toxicity of each sample location per the NOAA Sediment Quality Guidelines developed for the National Status and Trends Program (NOAA, 1999). Mean ERM-Qs may be useful in assessing the potential significance of chemical mixtures in sediment samples (NOAA, 1999). The information provided below should be used in combination with the information provided in the November letter report to aid in the determination of the appropriate course of action to be taken regarding sediments in Brinson Creek to ensure that no unacceptable risks are posed to the environment.

Data provided on Table 1 of the November letter report (attached) were used to calculate ERM-Qs for each chemical at each sampling location. ERM-Qs were calculated by dividing the concentration of each metal by their respective ERM value. Of the metals analyzed, ERMs have been established and ERM-Qs could be calculated for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. For non-detected inorganics at a given sampling location, ERM-Qs were calculated using one-half the detection limit. Rejected data (i.e., R-qualified data) were not used. It is noted that ERMs were not

available for 14 of the 23 inorganics analyzed. Thirteen of these inorganics were also lacking USEPA Region IV sediment screening values (Table 1). The lack of screening values is a common issue in risk evaluations and adds uncertainty to conclusions made regarding the potential toxicity of creek sediments.

Mean ERM-Qs were calculated for each sample location by taking the arithmetic average of available ERM-Qs. Mean ERM-Qs were used to categorize the sampling locations as follows (NOAA, 1999):

Category	Mean ERM-Q	Percent Highly Toxic Samples *	Average, Control-Adjusted Amphipod Survival (percent)*
1	< 0.1	9	93
2	0.11 - 0.5	21	86
3	0.51 – 1.5	49	70
4	> 1.5	76	41

(Adapted from NOAA 1999)
*Mean survival significantly different from controls and < 80% of controls. Data from combined summary (n=1513).

The above categories provide some indication of the relative likelihood that a given sample location will be toxic. Investigation of 1,513 data sets indicated a correlation between mean ERM-Qs and incidence of toxicity in amphipod survival tests (NOAA, 1999). Samples with higher mean ERM-Qs (e.g., Category 4) are more likely to be toxic and have lower average survival rates than those with lower ERM-Qs (e.g., Category 1). Although mean ERM-Qs were predictive of toxicity, there was uncertainty in these predictions. In the investigation, 9% of those samples classified in Category 1 (least likely to be toxic) based on ERM-Qs were toxic. Of the samples classified in Category 4 (most likely to be toxic) 76% were toxic. It is noted that samples classified in Category 2 have the most uncertainty as to toxicity because average survival in these samples approximated the critical threshold of 80% of controls rather than being clearly greater than or less than this threshold as in the other categories (NOAA, 1999).

Table A presents the metal-specific and mean ERM-Qs for each Brinson Creek sample location. Locations are listed from downstream to upstream on the table. Of the 23 sediment sample locations, six had mean ERM-Qs less than 0.1 and were placed in Category 1. The remaining 17 sample locations had mean ERM-Qs between 0.11 and 0.5 and were placed in Category 2. The sampling locations are shown on Figure 1.

The number of chemicals exceeding ERLs or ERMs can also be used to categorize sediment samples as follows (NOAA, 1999):

Category	Criteria	Percent Highly Toxic Samples *	Average, Control-Adjusted Amphipod Survival (percent)*
1	No ERLs exceeded	9	92
2	1 – 5 ERMs exceeded	32	79
3	6 – 10 ERMs exceeded	57	59
4	> 10 ERMs exceeded	80	41

(Adapted from NOAA 1999)
*Mean survival significantly different from controls and < 80% of controls. Data from combined summary (n=1,513).

When these counts are used to categorize the Brinson Creek sediment samples, the categories differ in some cases from categories based on mean ERM-Qs. Four samples classified in Category 2 based on mean ERM-Qs were classified in Category 1 based on counts. Twelve samples did not fall in to any category based on counts because at these locations more than one ERL was exceeded but no ERMs were exceeded. Table 1 has been amended to show categories based on the ERL and ERM counts. It is useful to consider both mean ERM-Q classifications and the exceedence of ERMs or ERLs by individual chemicals when evaluating the potential toxicity of sediments.

The highest mean ERM-Qs were calculated for sample stations IR36-SD04-01C, IRBC-SD01-02A, and IR36-SD03-01C (Table A). Each of these stations is located in the downstream portion of the creek (Figure 1). The mean ERM-Q for sample station IR36-SD04-01C (farthest downgradient location) is 0.49, placing it near the border of Category 2 and Category 3. Mercury and zinc are the risk-driving chemicals at this location, each present at concentrations exceeding their respective ERMs (i.e, with individual ERM-Qs exceeding 1.0 [ERM-Qs = 2.3944 and 1.6878, respectively]). If both mercury and zinc were not present at this location (i.e., if the mean ERM-Q were calculated without these chemicals), the mean ERM-Q would drop below 0.1, placing this location in Category 1.

The mean ERM-Q for sample station IRBC-SD01-02A is 0.41. Silver is indicated to be the risk-driving chemical at this location, with an ERM-Q of 1.1892. However, it is noted that silver was not detected at this sample location and that the ERM-Q for silver was calculated using one-half the detection limit (4.4 mg/kg). If the mean ERM-Q were calculated without silver, this location would still be classified in Category 2 (mean ERM-Q excluding silver = 0.32).

The mean ERM-Q for sample station IR36-SD03-01C is 0.39. Nickel and zinc are the risk-driving chemicals at this location, with ERM-Qs of 1.1919 and 1.2878, respectively. If the mean ERM-Q were calculated without nickel and zinc, the mean ERM-Q would be 0.11, just high enough for the sample station to remain in Category 2.

None of the remaining sampling stations had chemicals with individual ERM-Qs exceeding 1.0.

There are multiple limitations of using sediment quality guidelines (SQGs) such as ERLs, ERMs, and ERM-Qs to predict sediment toxicity. These limitations are noted by NOAA and include the following:

> "There are no SQGs available for many substances that can be highly toxic in sediments. The abilities of the SQGs to correctly predict toxicity of co-varying substances for which there are no SQGs are unknown. The SQGs were derived in units of dry weight sediments; therefore, they do not account for the potential effects of geochemical factors in sediments that may influence contaminant bioavailablilty. The SQGs were not intended for use in predicting effects in wildlife or humans through bioaccumulation pathways. The SQGs were neither calculated nor intended as toxicological thresholds; therefore, there is no certainty that they will always correctly predict either non-toxicity or toxicity." (NOAA, 1999).

These uncertainties should be taken in to consideration when determining the need for further evaluation or actions to address metal contamination in Brinson Creek.

Buchman, M.F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pages.

National Oceanic and Atmospheric Association (NOAA), 1999. Sediment Quality Guidelines developed for the National Status and Trends Program. June 12, 1999.

Baker appreciates the opportunity to serve LANTDIV on this important project. Should you have any questions regarding this submittal, please contact me at 412-269-2033.

Sincerely,

BAKER ENVIRONMENTAL, INC.

Richard E. Bonelli, P.G.
Activity Manager

REB/lp
Attachment

cc: Mr. Daniel Hood, LANTDIV, Code EV23 (one copy)
Mr. Rick Raines, MCB, Camp Lejeune (one copy)
Mr. Thomas Burton, MCB, Camp Lejeune (one copy)
Ms. Gena Townsend, USEPA (one copy)
Mr. Randy McElveen, NC DENR (one copy)
Mr. David Lilley, NC DENR (one copy)
Ms. Diane Rossi, NC DENR (one copy)
Mr. Ron Kenyon, Shaw (one copy)
Mr. Scott Bailey, CH2M Hill (one copy)
Mr. Chris Bozzini, CH2M Hill (one copy)

TABLE 1 (Amended from November 2002 letter report)
BRINSON CREEK SEDIMENT DATA COMPARED TO MARINE SEDIMENT SCREENING VALUES
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	USEPA Region IV Sediment Screening Value (mg/kg)	Marine Sediment Screening Value (mg/kg) ERL - ERM	Sample Location and Date (downstream to upstream)							
			IR36-SD04-01C 07/17/01	IRBC-SD01-02A 2/15/2002	IR36-SD05-01C 07/17/01	IRBC-SD02-02A 2/15/2002	IR36-SD03-01C 07/17/01	IRBC-SD03-02A 2/15/2002	IR36-SD02-01C 07/17/01	IRBC-SD04-02A 2/15/2002
Aluminum	NA	NA	1220	16600	21600	5120	8790	10500	33200	3950
Antimony	2	NA	1 U	52.9 UJ	5.3 U	14.5 UJ	0.86 U	30.2 UJ	2.45 U	19 UJ
Arsenic	7.24	8.2 - 70	1.1 J	**14**	4.4 J	2.7	1.8 J	4.3 J	4.2 J	2.1 J
Barium	NA	NA	6.7 J	44.1 J	31.4 J	16.1 J	24.8 J	22.9 J	43.4 J	10.2 J
Beryllium	NA	NA	0.13 U	0.78 J	0.72 U	0.21 J	0.25 U	0.42 J	0.84 J	1.6 U
Cadmium	0.676	1.2 - 9.6	0.35 J	0.89 J	**1.4 J**	0.16 J	**2.5**	0.48 J	0.45 J	1.6 U
Calcium	NA	NA	48300	12000	7460	2310	18500	4060	4000	2430
Chromium	52.3	81 - 370	6.2	41	30.6	12.9	20.2	21.5	36.1	6.7
Cobalt	NA	NA	0.89 J	8 J	5.2 J	1.6 J	8.7 J	3.1 J	3.5 J	1.1 J
Copper	18.7	34 - 270	14.1	26.8	**34.9 J**	10.6	**93.5**	13.1	27.4	5.4 J
Iron	NA	NA	5810	32200	23800	8520	43500	14300	13100	4760
Lead	30.2	46.7 - 218	18.6	**101**	**78.2**	20.4	45	44.3	**89.4**	13.2
Magnesium	NA	NA	1130 J	7180	3850 J	1480	1420	2540	2760 J	793 J
Manganese	NA	NA	719	160	114	48	24.5	46.6	37.1	36.5
Mercury	0.13	0.15 - 0.71	**1.7**	**0.47 J**	0.49 U	**0.17 J**	0.08 U	**0.21 J**	0.29 U	0.04 J
Nickel	15.9	20.9 - 51.6	3.1 U	**23.3 J**	18 J	8.8 J	**61.5**	8.4 J	12.1 J	3.2 J
Potassium	NA	NA	360 J	4560	1770 J	1260	312 J	1890 J	1280 J	524 J
Selenium	NA	NA	0.83 U	3.7 J	4.42 U	1.4	0.72 U	2.5 U	2.04 U	1.3 J
Silver	0.733	1 - 3.7	0.36 J	8.8 U	**3.1 J**	2.4 U	0.27 J	5 U	0.73 U	3.2 U
Sodium	NA	NA	1240 J	14300	12000	3150	863 J	4970	3890	1700
Thallium	NA	NA	1.3 U	8.8 U	6.89 U	2.4 U	1.12 U	5 U	3.18 U	3.2 U
Vanadium	NA	NA	4.7 J	49	43.6 J	24.5	62.2	19.7 J	43.6	6.8 J
Zinc	124	150 - 410	**692**	**190 J**	**231**	64 J	**528**	101 J	140	33.1 J
Count exceeding ERL			2	5	5	1	4	1	1	0
Count exceeding ERM			2	0	0	0	2	0	0	0
Category [1]			2	NA	NA	NA	2	NA	NA	1
Category based on mean ERM-Q [2]			2	2	2	2	2	2	2	1

Notes:

mg/kg = milligram per kilogram ERM = Effects Range Medium NA = Not Available or Not Applicable U = Not detected
ERL = Effects Range Low J = Value is estimated R = Value is rejected, data unusable.

United States Environmental Protection Agency (USEPA) Region IV Sediment Screening Values are Effects Values from USEPA Region IV, 2000. Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders.

Marine Sediment Screening Values from Buchman, M.F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pages.

[1] Category based on number of chemicals exceeding ERL or ERM (NOAA 1999). Category 1 = lowest probability of toxicity; catetory 4 = highest probability.

[2] Category based on value of mean ERM-Q (NOAA 1999; see Table A)

Bold font = detected concentration exceeds ERL.

Bold and shaded font = detected concentration exceeds ERL and ERM.

TABLE 1 (Continued)
BRINSON CREEK SEDIMENT DATA COMPARED TO MARINE SEDIMENT SCREENING VALUES
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	Marine Sediment Screening Value (mg/kg) ERL - ERM	Sample Location and Date (downstream to upstream)								
		IR36-SD01-01C 07/17/01	IRBC-SD05-02A 2/15/2002	IRBC-SD06-02A 2/15/2002	IRBC-SD07-02A 2/15/2002	IRBC-SD08-02A 2/15/2002	IRBC-SD09-02A 2/15/2002	IR35-DS01SD-02A 2/16/2002	IR35-DS02SD-02A 2/16/2002	IR35-DS03SD-02A 2/16/2002
Aluminum	NA	23800	21000	10800	12500	13500	12400	13400	4600	7180
Antimony	NA	3.76 U	29.7 UJ	21.8 UJ	16.7 UJ	20.6 UJ	16.9 UJ	19.1 UJ	9.6 UJ	11 UJ
Arsenic	8.2 - 70	3.1 J	4.8 J	4.4	4.4	3.6	3.5	6.9	2	2.6
Barium	NA	37.1 J	45 J	28.3 J	35.2 J	37 J	30.1 J	64.4	15.2 J	34.1 J
Beryllium	NA	0.77 J	0.61 J	0.45 J	0.6 J	0.48 J	0.42 J	0.87 J	0.19 J	0.32 J
Cadmium	1.2 - 9.6	0.37 J	0.42 J	0.53 J	0.46 J	0.58 J	0.41 J	0.74 J	0.19 J	0.37 J
Calcium	NA	13600	8720	9360	4270	7510	4960	24500	6400	5390
Chromium	81 - 370	22.9	22.7	26.2	17.5	26.7	16.5	36.1	10.4	11.2
Cobalt	NA	3.1 J	3.6 J	3.7 J	3.8 J	3 J	2.7 J	5.2 J	1.2 J	2.4 J
Copper	34 - 270	10.1 J	13.4	13	14.8	13.8	11.7	18.6	4.4	10
Iron	NA	12300	11800	16400	16300	12300	13100	20000	5270	9740
Lead	46.7 - 218	22.6	**80.3**	38.9	**59.9**	**81**	**52.4**	42.4	12.7	45.1
Magnesium	NA	2260 J	2200 J	2320	2030	2690	1400 J	2500	1050	620 J
Manganese	NA	24.2	34.1	58.4	42.5	40.3	32.5	54.5	13.3	23
Mercury	0.15 - 0.71	0.09 U	0.49 R	0.13 J	0.11 J	**0.23 J**	0.13 J	0.13 J	0.034 J	0.098 J
Nickel	20.9 - 51.6	8.5 J	8.9 J	10.5 J	7.3 J	8.8 J	5.9 J	13.5	3.3 J	4.2 J
Potassium	NA	1250 J	1070 J	2250	878 J	1670 J	863 J	2360	998	476 J
Selenium	NA	3.13 U	3	2.5	1.3 J	1.1 J	1.7	2.3	0.63 J	0.97
Silver	1 - 3.7	**1.3 J**	4.9 U	3.6 U	2.8 U	3.4 U	2.8 U	3.2 U	1.6 U	1.8 U
Sodium	NA	3140 J	2200 J	2070	1490	1950	1600	1690	2490	640 J
Thallium	NA	4.88 U	4.9 U	3.6 U	2.8 U	3.4 U	2.8 U	3.2 U	1.6 U	1.8 U
Vanadium	NA	26.3 J	26.4	20.6	24.4	21.2	22	28.2	8	13
Zinc	150 - 410	30.5	98.8 J	117 J	125 J	104 J	102 J	142 J	38 J	87.1 J
Count exceeding ERL		1	1	0	1	2	1	0	0	0
Count exceeding ERM		0	0	0	0	0	0	0	0	0
Category		NA	NA	1	NA	NA	NA	1	1	1
Category based on ERM-Q		1	2	2	2	2	2	2	1	2

Notes:

mg/kg = milligram per kilogram ERM = Effects Range Medium NA = Not Available or Not Applicable U = Not detected
ERL = Effects Range Low J = Value is estimated R = Value is rejected, data unusable.

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[1] Category based on number of chemicals exceeding ERL or ERM (NOAA 1999). Category 1 = lowest probability of toxicity; catetory 4 = highest probability.

[2] Category based on value of mean ERM-Q (NOAA 1999; see Table A)

Bold font = detected concentration exceeds ERL.

Bold and shaded font = detected concentration exceeds ERL and ERM.

TABLE 1 (Continued)
BRINSON CREEK SEDIMENT DATA COMPARED TO MARINE SEDIMENT SCREENING VALUES
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	Marine Sediment Screening Value (mg/kg) ERL - ERM	Sample Location and Date (downstream to upstream)						Frequency of Exceedence of ERL Value	CREEK AVERAGE (1/2 Non-detects
		IRBC-SD10-02A 2/15/2002	IRBC-SD11-02A 2/15/2002	IRBC-SD12-02A 2/15/2002	IRBC-SD13-02A 2/15/2002	IRBC-SD14-02A 2/15/2002	IRBC-SD15-02A 2/15/2002		
Aluminum	NA	14400	7300	8030	1650	921	622	NA	11004
Antimony	NA	22.5 U	15.5 U	15.1 UJ	9.9 UJ	7.8 UJ	7.4 UJ	NA	7.7
Arsenic	8.2 - 70	5.6	3.4	3.6	0.73 J	0.4 J	1.2 U	1/23	3.7
Barium	NA	41.7 J	21.5 J	38.7 J	11.8 J	8.6 J	4.2 J	NA	28.4
Beryllium	NA	0.67 J	0.38 J	0.43 J	0.097 J	0.65 U	0.071 J	NA	0.447
Cadmium	1.2 - 9.6	0.68 J	0.39 J	0.56 J	0.11 J	0.06 J	0.62 U	2/23	0.57
Calcium	NA	14800	7100	3310	2070	1700	4030	NA	9425
Chromium	81 - 370	28.4	16.8	12.5	3.1	3	1.2	0/23	18.7
Cobalt	NA	4.8 J	2.9 J	3.4 J	1.3 J	0.38 J	0.36 J	NA	3.21
Copper	34 - 270	18.9	9.6	12.7	2.6 J	3.3 U	3.1 U	2/23	16.6
Iron	NA	19600	11100	13400	3570	854	1080	NA	13600
Lead	46.7 - 218	**58.1**	23.3	**94.9**	7.6	3.6	3.6	9/23	45.1
Magnesium	NA	2540	1530	1370	213 J	70.3 J	71.2 J	NA	1913.8
Manganese	NA	56.2	37.9	26	13.4	7.3	3	NA	71.8
Mercury	0.15 - 0.71	0.065 J	0.028 J	0.077 J	0.17 R	0.13 R	0.03 J	5/20	**0.21**
Nickel	20.9 - 51.6	11.7 J	6.2 J	5.4 J	1.5 J	1 J	0.49 J	2/23	10.18
Potassium	NA	1910	1180 J	515 J	117 J	77.1 J	24.9 J	NA	1199.8
Selenium	NA	2.1	1.1 J	1.2 J	0.83 U	0.65 U	0.62 U	NA	1.40
Silver	1 - 3.7	3.7 U	2.6 U	2.5 U	1.7 U	1.3 U	1.2 U	2/23	**1.5**
Sodium	NA	1400 J	1700	1480	353 J	653 U	620 U	NA	2824
Thallium	NA	3.7 U	2.6 U	2.5 U	1.7 U	1.3 U	1.2 U	NA	1.6
Vanadium	NA	26.7	15.9	14.9	3.7 J	2.1 J	1.2 J	NA	22.1
Zinc	150 - 410	**156 J**	78.4 J	122 J	27.8 J	10 J	8 J	5/23	140
Count exceeding ERL		2	0	1	0	0	0	--	--
Count exceeding ERM		0	0	0	0	0	0	--	--
Category		NA	1	NA	1	1	1	--	--
Category based on ERM-Q		2	2	2	1	1	1	--	--

Notes:

mg/kg = milligram per kilogram ERM = Effects Range Medium NA = Not Available or Not Applicable U = Not detected
ERL = Effects Range Low J = Value is estimated R = Value is rejected, data unusable.

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[1] Category based on number of chemicals exceeding ERL or ERM (NOAA 1999). Category 1 = lowest probability of toxicity; catetory 4 = highest probability.

[2] Category based on value of mean ERM-Q (NOAA 1999; see Table A)

Bold font = detected concentration exceeds ERL.

Bold and shaded font = detected concentration exceeds ERL and ERM.

TABLE A
ERM QUOTIENTS FOR METALS IN BRINSON CREEK
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	Marine Sediment Screening Value (mg/kg) ERM (mg/kg)	Sample Location (downstream to upstream)										
		IR36-SD04-01C ERM-Q	IRBC-SD01-02A ERM-Q	IR36-SD05-01C ERM-Q	IRBC-SD02-02A ERM-Q	IR36-SD03-01C ERM-Q	IRBC-SD03-02A ERM-Q	IR36-SD02-01C ERM-Q	IRBC-SD04-02A ERM-Q	IR36-SD01-01C ERM-Q	IRBC-SD05-02A ERM-Q	IRBC-SD06-02A ERM-Q
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	70	0.0157	0.2000	0.0629	0.0386	0.0257	0.0614	0.0600	0.0300	0.0443	0.0686	0.0629
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	9.6	0.0365	0.0927	0.1458	0.0167	0.2604	0.0500	0.0469	0.0833	0.0385	0.0438	0.0552
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	370	0.0168	0.1108	0.0827	0.0349	0.0546	0.0581	0.0976	0.0181	0.0619	0.0614	0.0708
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	270	0.0522	0.0993	0.1293	0.0393	0.3463	0.0485	0.1015	0.0200	0.0374	0.0496	0.0481
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	218	0.0853	0.4633	0.3587	0.0936	0.2064	0.2032	0.4101	0.0606	0.1037	0.3683	0.1784
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.71	**2.3944**	0.6620	0.3451	0.2394	0.0563	0.2958	0.2042	0.0563	0.0634	NA	0.1831
Nickel	51.6	0.0300	0.4516	0.3488	0.1705	**1.1919**	0.1628	0.2345	0.0620	0.1647	0.1725	0.2035
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	3.7	0.0973	**1.1892**	0.8378	0.3243	0.0730	0.6757	0.0986	0.4324	0.3514	0.6622	0.4865
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	410	**1.6878**	0.4634	0.5634	0.1561	**1.2878**	0.2463	0.3415	0.0807	0.0744	0.2410	0.2854
Mean ERM-Q		**0.49**	**0.41**	**0.32**	**0.12**	**0.39**	**0.20**	**0.18**	**0.09**	**0.10**	**0.21**	**0.17**
Category		**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**

Notes:

mg/kg = milligram per kilogram

ERM = Effects Range Median (Buchman 1999)

ERM-Q = ERM quotient = metal concentration / ERM (see Table 1 of October letter report for raw data)

NA = Not Available or Not Applicable

If a metal was not detected at a given sample location, the ERM-Q was calculated using one-half the detection limit

ERM-Q values were not calculated if data were rejected (R-qualified)

Mean ERM-Q = sum of available ERM-Q from each location / number of available ERM-Q values

Bold font indicates ERM-Qs greater than 1.0 (chemical concentration > ERM)

Category = Four categories corresponding to probabilities of amphipod toxicity, are defined as follows (NOAA 1999):

Category 1: mean ERM-Q < 0.1 (lowest probability)

Category 2: mean ERM-Q 0.11 - 0.5

Category 3: mean ERM-Q 0.51 - 1.5

Category 4: mean ERM-Q > 1.5 (highest probability)

Sediment samples may alternatively be categorized based on the number of chemicals exceeding ERL or ERM values (NOAA 1999; see Table 1).

TABLE A (Continued)
ERM QUOTIENTS FOR METALS IN BRINSON CREEK
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	Marine Sediment Screening Value (mg/kg) ERM	Sample Location (downstream to upstream)									
		IRBC-SD07-02A ERM-Q	IRBC-SD08-02A ERM-Q	IRBC-SD09-02A ERM-Q	IR35-DS01SD-02A ERM-Q	IR35-DS02SD-02A ERM-Q	IR35-DS03SD-02A ERM-Q	IRBC-SD10-02A ERM-Q	IRBC-SD11-02A ERM-Q	IRBC-SD12-02A ERM-Q	IRBC-SD13-02A ERM-Q
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	70	0.0629	0.0514	0.0500	0.0986	0.0286	0.0371	0.0800	0.0486	0.0514	0.0104
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	9.6	0.0479	0.0604	0.0427	0.0771	0.0198	0.0385	0.0708	0.0406	0.0583	0.0115
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	370	0.0473	0.0722	0.0446	0.0976	0.0281	0.0303	0.0768	0.0454	0.0338	0.0084
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	270	0.0548	0.0511	0.0433	0.0689	0.0163	0.0370	0.0700	0.0356	0.0470	0.0096
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	218	0.2748	0.3716	0.2404	0.1945	0.0583	0.2069	0.2665	0.1069	0.4353	0.0349
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.71	0.1549	0.3239	0.1831	0.1831	0.0479	0.1380	0.0915	0.0394	0.1085	NA
Nickel	51.6	0.1415	0.1705	0.1143	0.2616	0.0640	0.0814	0.2267	0.1202	0.1047	0.0291
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	3.7	0.3784	0.4595	0.3784	0.4324	0.2162	0.2432	0.5000	0.3514	0.3378	0.2297
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	410	0.3049	0.2537	0.2488	0.3463	0.0927	0.2124	0.3805	0.1912	0.2976	0.0678
Mean ERM-Q		**0.16**	**0.20**	**0.15**	**0.20**	**0.06**	**0.11**	**0.20**	**0.11**	**0.16**	**0.05**
Category		**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**

Notes:

mg/kg = milligram per kilogram

ERM = Effects Range Median (Buchman 1999)

ERM-Q = ERM quotient = metal concentration / ERM (see Table 1 of October letter report for raw data)

NA = Not Available or Not Applicable

If a metal was not detected at a given sample location, the ERM-Q was calculated using one-half the detection limit

ERM-Q values were not calculated if data were rejected (R-qualified)

Mean ERM-Q = sum of available ERM-Q from each location / number of available ERM-Q values

Bold font indicates ERM-Qs greater than 1.0 (chemical concentration > ERM)

Category = Four categories corresponding to probabilities of amphipod toxicity, are defined as follows (NOAA 1999):

Category 1: mean ERM-Q < 0.1 (lowest probability)
Category 2: mean ERM-Q 0.11 - 0.5
Category 3: mean ERM-Q 0.51 - 1.5
Category 4: mean ERM-Q > 1.5 (highest probability)

Sediment samples may alternatively be categorized based on the number of chemicals exceeding ERL or ERM values (NOAA 1999; see Table 1).

TABLE A (Continued)
ERM QUOTIENTS FOR METALS IN BRINSON CREEK
SITE 35 - FORMER CAMP GEIGER FUEL FARM
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

METALS (mg/kg)	Marine Sediment Screening Value (mg/kg) ERM	Sample Location (downstream to upstream)	
		IRBC-SD14-02A ERM-Q	IRBC-SD15-02A ERM-Q
Aluminum	NA	NA	NA
Antimony	NA	NA	NA
Arsenic	70	0.0057	0.0086
Barium	NA	NA	NA
Beryllium	NA	NA	NA
Cadmium	9.6	0.0063	0.0323
Calcium	NA	NA	NA
Chromium	370	0.0081	0.0032
Cobalt	NA	NA	NA
Copper	270	0.0061	0.0057
Iron	NA	NA	NA
Lead	218	0.0165	0.0165
Magnesium	NA	NA	NA
Manganese	NA	NA	NA
Mercury	0.71	NA	0.0423
Nickel	51.6	0.0194	0.0095
Potassium	NA	NA	NA
Selenium	NA	NA	NA
Silver	3.7	0.1757	0.1622
Sodium	NA	NA	NA
Thallium	NA	NA	NA
Vanadium	NA	NA	NA
Zinc	410	0.0244	0.0195
Mean ERM-Q		**0.03**	**0.03**
Category		**1**	**1**

Notes:

mg/kg = milligram per kilogram

ERM = Effects Range Median (Buchman 1999)

ERM-Q = ERM quotient = metal concentration / ERM (see Table 1 of October letter report for raw data)

NA = Not Available or Not Applicable

If a metal was not detected at a given sample location, the ERM-Q was calculated using one-half the detection limit

ERM-Q values were not calculated if data were rejected (R-qualified)

Mean ERM-Q = sum of available ERM-Q from each location / number of available ERM-Q values

Bold font indicates ERM-Qs greater than 1.0 (chemical concentration > ERM)

Category = Four categories corresponding to probabilities of amphipod toxicity, are defined as follows (NOAA 1999):

Category 1: mean ERM-Q < 0.1 (lowest probability)
Category 2: mean ERM-Q 0.11 - 0.5
Category 3: mean ERM-Q 0.51 - 1.5
Category 4: mean ERM-Q > 1.5 (highest probability)

Sediment samples may alternatively be categorized based on the number of chemicals exceeding ERL or ERM values (NOAA 1999; see Table 1).

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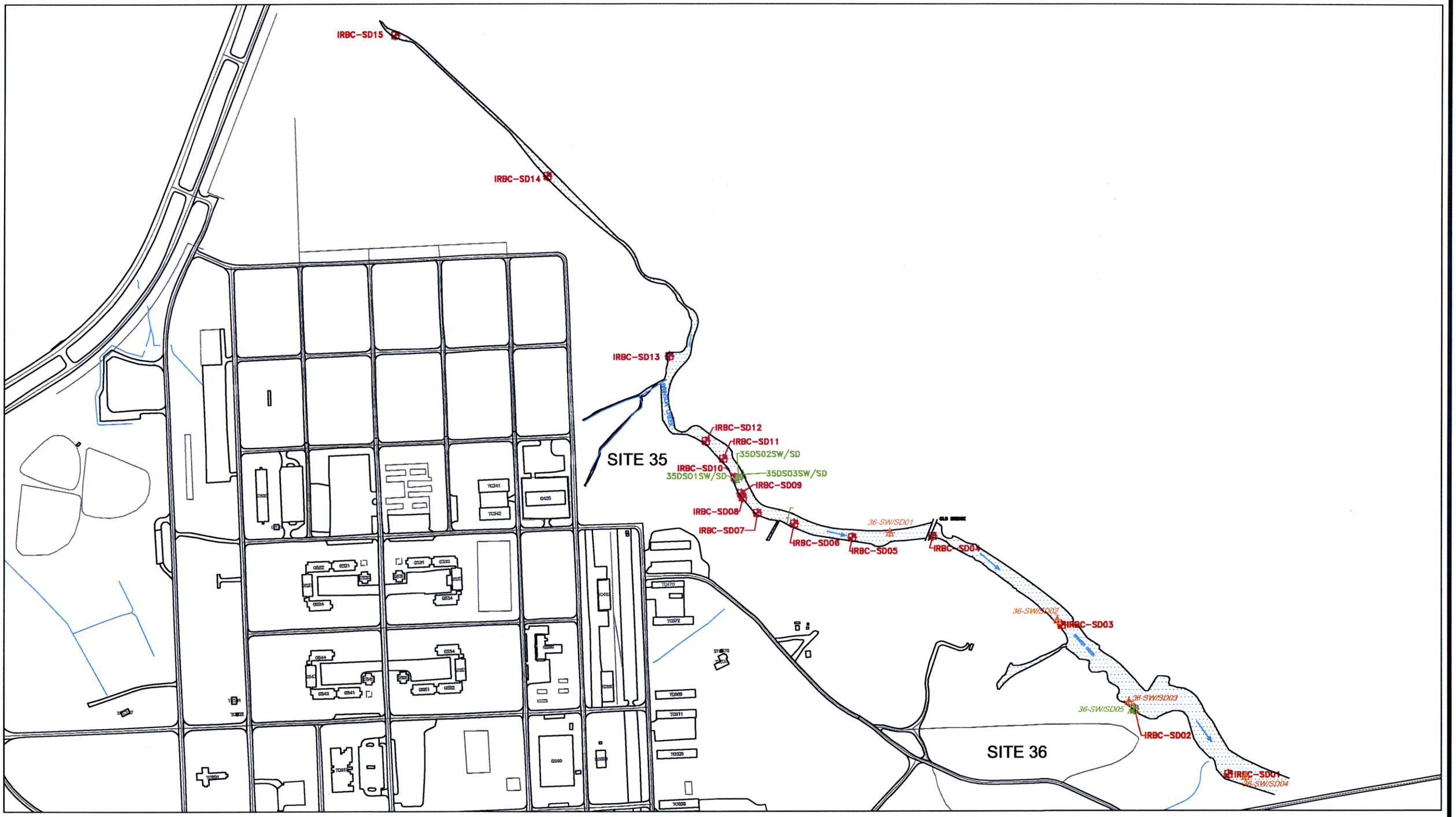

200 0 100 200
1 inch = 200 ft.

Baker
Baker Environmental Inc.

LEGEND

IRBC-SD01 – SEDIMENT SAMPLE LOCATION (2002)
35DSOISW/SD – SEDIMENT SAMPLE LOCATION (2002)
SW/SD05 – SEDIMENT LOCATION (2001)
36-SW/SD04 – SEDIMENT SAMPLE LOCATION (2002)
– CREEK FLOW DIRECTION LOCATION

FIGURE 1
SEDIMENT SAMPLE LOCATIONS
BRINSON CREEK
CTO-0219
JUNE 2003

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA